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FURTHER CYANIDE TESTS ON A SAMPLE OF OXIDIZED Ag-Au TAILINGS FROM THE WEATON MINE, MONTAUBAN, QUEBEC

by

A.I. Stemerowicz* and G.W. Leigh**

ABSTRACT

Additional cyanide tests were carried out on a sample of the oxidized mill tailings. The object of the tests was to determine whether or not cyanide consumption could be reduced to an acceptable level by a thorough removal of cyanide-consuming oxidation products prior to cyanidation. This was accomplished by 4 stages of water washing followed by an acid wash. This treatment was not effective in reducing cyanide consumption which at 43.1 kg/tonne was almost twice as high as that obtained in a previous test in which only one stage of water washing was employed. Higher silver and gold recoveries were obtained however - 71.7% and 92.8% respectively compared to the 57.5% and 73.3% recoveries obtained in previous tests. The high cyanide consumption is attributed to the high elemental sulphur content in the feed which consumes cyanide by reacting with it to form thiocyanate. Two other factors which would make the treatment of the tailings in a conventional cyanide plant very difficult if not impossible are the extremely slow settling and filtering characteristics of the solids.

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INTRODUCTION

Background

In previous work done by Lakefield Research, gold and silver extractions of 90% and 80% respectively were obtained by cyaniding the tailings but reagent consumption was very high - 58 kg/tonne for cyanide and 96 kg/tonne for lime (CaO). The high reagent consumption is attributed to the fact that soluble oxidation products which react with cyanide were not removed from the tailings sample prior to cyanidation.

In May 1983 two cyanide tests were carried out at the Mineral Sciences Laboratories in which (1) water washing and (2) roasting were employed as a means of removing the deleterious soluble oxidation products in the tailing prior to cyanidation (1). A substantial reduction in cyanide and lime consumption was obtained but extraction of precious metals was lower than that obtained in the Lakefield Research tests. On the washed tailings cyanidation gave silver and gold extractions of 57.5% and 73.3% respectively while on the roasted tailings the comparable figures were 53.9% and 67.3%. The lowest cyanide consumption was obtained on the roasted material - 18 kg/tonne compared to 25.2 kg/tonne on the washed material. Although greatly reduced from the 58 kg/tonne consumed in the Lakefield Research tests, cyanide consumption was still very high by normal standards.

Object of tests

The object of the tests was to determine whether or not cyanide consumption could be further reduced by a more thorough removal of cyanide-consuming oxidation products prior to cyanidation. This was to be done by multi-stage water washing followed by an acid wash. In the previous work, only one stage of water washing had been employed and it was felt that this may have not been adequate to remove all of the deleterious oxidation products. These washing steps could readily be incorporated in the adjacent Muscocho Explorations cyanide plant which would consider treating the tailings on a custom basis provided the reagent consumption problem was overcome.

Source of Sample

A new sample of oxidized Weaton mill tailings was obtained by removing about 30 kg of material from the bottom of one of the 45-gal (170.3L) steel drums stored by Mr. C.M. Sheahan in the Ottawa area. Mr. Sheahan stated that the tailings had been in storage for about 2 years. The material at the top of the drums was dry, caked and coated with yellow layers of what appeared to be elemental sulphur. It was therefore decided to dump one of the drums and remove the, fresher, wetter material near the bottom.

Sampling and Analysis

An attempt was made to homogenize the sample by breaking up the lumps through a 6-mesh (3.327 mm) screen. This technique was ineffective because the lumps were composed of very wet and fine sticky slimes. The lumps were therefore broken up by hand and four 2000-gram lots were riffled out. One of these lots was chosen as the head sample.

Table 1: Head sample analysis

Silver (Ag)	986 g/t (28.8 oz/ton)
Gold (Au)	10.7 g/t (0.31 oz/ton)
Iron (Fe)	45.40%
Copper (Cu)	0.03%
Lead (Pb)	3.98%
Zinc (Zn)	0.16%
Insol (Insolubles)	6.10%
Elemental sulphur (S)	7.76%
Total sulphur	9.26%
Moisture	19.1%

TEST PROCEDURE

Washing

A 2500-gram sample of wet tailings was pulped with 7 litres of cold tap water and agitated for 15 minutes in a Denver 8-litre lab flotation

cell followed by a further 5 minute mixing period with a flocculant. The impeller was then stopped and the solids allowed to settle. The clear solution was removed by suction through a gooseneck inlet using a small peristaltic pump. An equivalent amount of fresh water was then added to the lab cell and the procedure was repeated 3 more times with tap water and once with a 3% by weight sulphuric acid solution. In Table 2 the washing procedure is outlined in detail.

Table 2: Washing procedure

Operation	Solution added litres	Agitation time min (1)	Settling time h (2)	Solution withdrawn litres	Solution pH
Water wash-1	water 7.0	15	1.75	4.12	2.36
Water wash-2	water 4.12	15	2.0	4.36	2.4
Water wash-3	water 4.36	15	18.75	4.92	2.5
Water wash-4	water 5.0	60	22.5	5.0	2.75
Acid wash	acid, 30 g/L H_2SO_4 5.0	410	12.0	7.48(3)	1.36

Notes:

(1) At impeller speed of 1500 RPM

(2) For flocculation of slimes added 0.015 g/L Superfloc 16 and agitated for 5 min at impeller speed of 1000 RPM prior to settling

(3) Calculated total amount of solution - 7 litres + 0.48 litres moisture in original wet sample

Cyanidation

The washed tailings sample was filtered and the filter cake was washed twice with tap water to remove the last traces of acid solution. The wet filter cake (moisture content, 29%) was then split into quarters. Two of these quarters were used as feed to the cyanide tests while the remaining quarters were dried for assay and size analysis. Cyanidation was tried

with and without prior regrinding and was preceded by a 4-hour aeration step carried out in a 500-gram Denver lab flotation machine. The aerated pulp was transferred to a large bottle, water was added to make up a volume of 2 litres for a pulp density of about 20% solids and the pulp was agitated on rolls for 48 hours at a nominal solution strength of 2 g/L NaCN and a pH of 12.0. Test details are given in tabular form in Table 3.

Table 3: Cyanidation test procedure

Operation	Test B-1	Test B-2
Regrinding	none	30 min in 8-inch diam ceramic ball mill with ceramic balls
Aeration	4 h in 500-g lab froth cell with 13 g lime pH at end 11.3	as in B-1 pH at end 11.2
Cyanidation	48 h in bottle agitated on rolls at 20% solids	as in B-1
Solution strength	2.0 g/L NaCN	as in B-1
Solution pH	12	as in B-1
Charge: ¼ of wet filter cake after washing (29% moisture) estimated to have a dry weight of 500 g		

RESULTS

Washing

The analyses of the various wash solutions are given in Table 4. As noted the soluble weight loss was 12.3%. Note the high silver content in the acid wash solution which accounted for 92% of the total silver lost in all the wash solutions.

Table 4: Analysis of wash solutions

Wash solution	Analysis - g/L except Ag in mg/L					
	Fe	Cu	Pb	Zn	Ag	Au
Water - 1	2.32	0.008	0.004	0.017	0.49	tr
Water - 2	0.93	0.004	0.004	0.009	0.59	tr
Water - 3	0.27	0.001	0.004	0.004	0.46	tr
Water - 4	0.043	0.0005	0.004	0.002	0.43	tr
Acid	2.27	0.005	0.006	0.004	14.08	tr

Soluble losses:

In weight - 12.3%

Silver - 5.73% of the silver in the dry sample before washing

Cyanidation

Cyanidation results are given in Table 5 and 6 followed by Table 7 which gives the reagent consumption during cyanidation. In Table 5 and 6 the amount of precious metals recovered is taken as the difference in content of the cyanidation feed and residue. This method of calculation is preferred because it takes into account the precious metals lost in the solutions withdrawn for titration of solution strength (about 100 cc). Precious metal recoveries calculated from pregnant solution assays are given in footnotes to the tables.

Table 5: Results of cyanidation
Test B-1 - no regrind

Product	Amount	Assays, g/t		Content, mg		Recovery, %	
		Ag	Au	Ag	Au	Ag	Au
Pregnant soln*	1787 cc	191	2.6	341.2	4.64	71.7	92.8
Residue	473.6 g	284	0.76	134.5	0.36	28.3	7.2
Feed (assay)	485.4 g	980	10.3	475.7	5.00	100.0	100.0

* Assays and content obtained by difference - by assay Ag and Au in pregnant solution were 173 and 2.42 g/t respectively. Silver and gold recoveries calculated from pregnant solution assays were 69.6% and 92.3% respectively for a calculated feed of 937 g/t Ag and 9.9 g/t Au.

Table 6: Results of cyanidation
Test B-2 - feed reground

Product	Amount	Assays, g/t		Content, mg		Recovery, %	
		Ag	Au	Ag	Au	Ag	Au
Pregnant soln*	1781 cc	175	2.6	312.0	4.57	65.6	91.4
Residue	470.3 g	348	0.91	163.7	0.43	34.4	8.6
Feed (assay)	485.4 g	980	10.3	475.7	5.00	100.0	100.0

* Assays and content obtained by difference - by assay Ag and Au in pregnant solution were 165 and 2.6 g/t respectively. Silver and gold recoveries calculated from pregnant solution assays were 64.2% and 91.4% respectively for a calculated feed of 973 g/t Ag and 10.6 g/t Au.

Table 7: Reagents consumed during cyanidation

Test	Reagent consumption, kg/tonne feed	
	NaCN	Lime
B-1 - no regrind	43.1	6.5
B-2 - feed reground	41.8	6.6

Size Analysis of Cyanidation Feed

A sample of cyanidation feed was screened through a 32 µm sieve and the fractions assayed to determine the precious metal distribution. Results are given in Table 8.

Table 8: Precious metal distribution in coarse and fine fractions of cyanidation feed

Size fraction	Wt %	Assays, g/t		Distn %	
		Ag	Au	Ag	Au
+32 µm	12.55	423	16.6	5.3	22.1
-32 µm	87.45	1086	8.4	94.7	77.9
Feed (calc)	100.0	1003	9.4	100.0	100.0

DISCUSSION AND CONCLUSIONS

A substantial increase in silver and gold extraction by cyanidation was obtained in these tests (B-1, B-2) compared to the previous tests done in May (Tests A and B). For Test B-1 (without prior regrinding) silver and gold extractions were 71.7% and 92.8% respectively compared to 57.5% and 73.3% for Test A (1). However, despite thorough washing of the tailings sample with water and acid solution, cyanide consumption was not reduced in the subsequent cyanidation step. In Test B-1 cyanide consumption was 43.1 kg/tonne cyanided versus 25.2 kg/tonne for Test A carried out last May on a different sample. Also there was a wide discrepancy in soluble weight loss between the two tests. In Test B-1 a soluble weight loss of 12.3% was obtained versus 19.7% obtained in previous Test A in which the tailings sample was only washed once prior to cyanidation.

A difference in test procedure between the two series of tests was the water to solids ratio employed for cyanidation - 4:1 in this test series versus 2:1 for the tests done last May. This could have had an appreciable effect on both the precious metal extractions obtained and the amount of cyanide consumed.

Elemental sulphur content in Test B-1 cyanidation feed was 7.68% or 37.3 grams. Sulphur will react readily with an equal weight of cyanide to form sodium thiocyanate (NaCNS). If all the sulphur in the feed reacted with cyanide the result would be equivalent to a cyanide consumption of 76.8 kg/tonne which is more than enough to account for the 43:1 kg/tonne actually consumed in Test B-1. Roasting the sample prior to cyanidation as was done last May in Test B would eliminate the elemental sulphur. Also practically all the soluble, cyanide-consuming sulphates would be decomposed into oxides during the roast. Despite this, cyanide consumption was 18 kg/tonne for cyanidation of the roasted material. This suggests that some of the extremely fine particles of iron oxide which comprises about 2/3 of the tailings may react with cyanide to form iron cyanide complexes.

In addition to the high cyanide consumption, other factors which would make the treatment of these tailings in a conventional cyanide plant very difficult if not impossible are the extremely slow settling and filtering characteristics of the solids. During the washing procedure it was found that the material could only be thickened from an initial 21% solids to about 40% solids after a 2-hour settling period. An increase in settling time to 22.5 h only resulted in a further small compaction to about 45% solids. As noted, moisture content in the washed tailings filter cake was an extremely high 29% even after an 8-hour period of filtering in a high-pressure air filter. A normal cyanide plant filter cake would contain 8-10% moisture.

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